An ecosystem based approach to the assessment and governance of the Bay of Bengal Large Marine Ecosystem

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ABSTRACT

The Bay of Bengal Large Marine Ecosystem (BOBLME) is one of the largest and most important globally. In recent years Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand have come together to build consensus around a Strategic Action Programme (SAP) with the support of the Global Environment Facility (GEF) International Waters, Norway, Sweden and the Food and Agriculture Organisation of the United Nations (FAO). The Transboundary Diagnostic Analysis (TDA) process identified a number of key issues including overexploitation of marine living resources, degradation of critical habitats and pollution and water quality. The TDA process identified several key drivers which contribute to these issues. These include socioeconomic drivers, institutional, legal and administrative drivers and climate change. The agreed SAP identified four key objectives including that fisheries and other marine living resources are restored and managed sustainably; degraded, vulnerable and critical marine habitats are restored, conserved and maintained; coastal and marine pollution and water quality are controlled to meet agreed standards for human and ecosystem health; and social and economic constraints are addressed, which should lead to increased resilience and empowerment of coastal people. Analysis of the BOBLME SAP shows that just over 70% of the identified activities are being undertaken to some extent by countries already. SAP implementation recognises the importance of approaches such as the Ecosystem Approach to Fisheries (EAF), Integrated Coastal Management (ICM) and the focus on Small Scale Fisheries. Whilst BOBLME countries vary considerably in their governance arrangements and capacity to implement, they recognise the importance of regional coordination and cooperation to address transboundary issues.

1. Introduction

The Large Marine Ecosystem (LME) approach is a generally accepted multidisciplinary framework which enables region-wide analysis and identification of the ecosystem status and health, as well as key areas of concerns, e.g. causes of production variability. Most importantly, it develops agreed strategic action programmes to address issues related to fisheries, habitats and water quality. Pioneered in the 1980s (Sherman and Alexander, 1986) the approach has been refined and strengthened in recent years and is being adopted on a global scale (IOC-UNESCO and UNEP, 2016). LME units represent regional marine systems which respond to external stresses, such as overexploitation of commercially valuable fish and invertebrate species, degradation of critical habitats, environmental fluctuations and large-scale pollution and climate change. LMEs are examined through five linked modules: (1) productivity of the ecosystem; (2) fish and fisheries; (3) pollution

and ecosystem health; (4) socioeconomic conditions; and (5) governance (Juda and Hennessey, 2010; Sherman, 2014).

LMEs are considered important from a development perspective, in particular socio-economics in view of the ecosystem services they provide to the people depending on them. In addition to strengthening natural resource management and regional transboundary cooperation, they are also considered important approaches to achieve the United Nation's Sustainable Development Goals (SDGs) and in particular SDG 14 – LMEs having been called "an engine for achieving SDG 14" - but also SDG 1, 2, 8 and 12 (GEF, 2017; UNDP, 2017). Target 14.B provision of access for small-scale artisanal fishers to marine resources markets can only be achieved through supporting environmentally, economically and socially sustainable use and management of coastal fisheries – offering a venue for the LME approach to incorporate support to implementation of the Small-Scale Fisheries Guidelines (FAO, 2015). The Global Environment Facility (GEF), for implementation of projects

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of its International Waters portfolio, has adopted the LME Approach for achieving its objectives regarding biodiversity conservation and sustainable management of the world's oceans.

Globally there are 66 LMEs defined at present. The Bay of Bengal Large Marine Ecosystem (BOBLME) is one of the largest of these LMEs. The bordering countries include Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand (Fig. 1), and are some of the most populous in the world. Across the BOBLME there is huge diversity in culture, religion, and political and social systems, both between and within the countries of the BOBLME. Strong progress was made in recent years to build consensus and partnerships across the region and the GEF-funded project (with support from Sweden and Norway) to develop the Transboundary Diagnostic Analysis (TDA) and the Strategic Action Programme (SAP) started in 2009. This project built on existing experiences, frameworks and strengthened existing organisations. The TDA-SAP process was completed in 2015 and the development of a SAP implementation programme began (BOBLME, 2015a, 2015b).

2. Profile of the Bay of Bengal Large Marine Ecosystem (BOBLME)

The Bay of Bengal Large Marine Ecosystem (BOBLME) is over 6.2 million km^2 in area with a mostly narrow continental shelf around its perimeter. It reaches depths of 2000 and over 4000 m in its central area. Most of the BOBLME (66%) area is within the EEZs of its countries (Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, Thailand). Primary production is concentrated in the coastal waters. The Bay of Bengal is warming slowly (by 0.5 °C since 1957) and its average sea-surface temperature is 28.6 °C (Sherman and Hempel, 2009). Huge quantities of freshwater and silt enter the BOBLME through the major feeder rivers; the Ganges, Brahmaputra and Meghna (draining across Bangladesh and India); the Ayeyarwaddy, Sittaung and Thanlwin from Myanmar; the Mahanadi, Godavari, Krishna and Cauvery in the west from India. The Ganges-Brahmaputra-Meghna basin covers nearly 1.75 million km^2 crossing five countries. The BOBLME is strongly influenced by monsoonal rains which produce seasonal gyres and a warm, low salinity, nutrient- and oxygen-rich surface layers. Tides in the BOBLME are mainly semidiurnal with a wide range along some coasts.

The population in the region is around 1.78 billion and is forecast to reach 2 billion between 2020 and 2025. Importantly, over 450 million people rely on the LME for their food and livelihoods. Most are subsisting at or below poverty levels. Continuing degradation of the coastal and marine resources of the region is forecast to have significant negative impacts on the quality of life and on economic growth. Most these people are poor and rely heavily on the marine resources which are being affected by over-fishing, removal or degradation of important marine habitats, and pollution and climate change. India, Bangladesh, Myanmar and Maldives are among the countries most affected by climate change and extreme weather events. Marine maximum potential productivity is likely to decrease in the BOBLME region because of climate change, although that potential is not being achieved at present because of overfishing. This suggests that climate change impacts on specific fisheries can be partly mitigated by improving fisheries management. Internationally funded cooperative research and support programmes, such as the BOBLME Project, that encourage ecosystem- and community-based approaches and science-driven management advice, are a key response promoting climate change adaptation (Fernandes, 2018).

Despite these trends the BOBLME is still considered to be rich in natural resources with extensive mineral and energy resources; marine living resources that support major fisheries; and forest and land resources (Table 1). In terms of marine fisheries, production in 2012 (BOBLME, 2015a) was around 6 million tonnes including seven percent of the world's brackishwater and marine catch. This was valued at around USD 4 billion which is around four percent of the value of the

world catch. There are many important habitats in the BOBLME region including mangroves (with 12% of world mangrove resources); coral reefs (8% of the world's coral reefs) and seagrass. The BOBLME is characterized as an area of high biodiversity. In terms of resources, fishing, shrimp farming, tourism and shipping contribute to food security, employment and national economies of countries in the BOBLME. The area is considered rich for hydrocarbons. However, an increasing emphasis on the exploration for, and exploitation of, oil and gas in the BOBLME presents many different opportunities and threats. There is also an increasing risk of pollution, mainly from land-based sources, and including marine litter and plastics.

3. The BOBLME Project, TDA issues and causes

Under the "Sustainable Management of the Bay of Bengal Large Marine Ecosystem" project[1] Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand came together to undertake a Transboundary Diagnostic Analysis (TDA) and to develop a Strategic Action Programme (SAP). The TDA process identified a number of key issues (BOBLME, 2012). These included (i) over-exploitation of marine living resources, (ii) degradation of critical habitats and (iii) pollution and water quality (Table 2).

With respect to fishing and fisheries, in the BOBLME, there has been continued expansion of commercial fishing effort, over capitalisation, especially through increased horsepower and size of fishing vessels (BOBLME, 2012a, 2012b). Other issues include open access to fisheries in many areas along with the competitive nature of fishing. Fishing gear with very small mesh sizes are used in many areas destroying both the critical habitats and the fish resource itself. The large number of juveniles and sub-adults taken before they have a chance to breed continues to impact stocks.

Mangroves have been classified as either degraded or under threat in all BOBLME countries. Over 4500 km^2 of mangroves have been lost in the region over the last 30 years. Coral reefs are also classified as degraded or under threat. Reefs considered to be at greatest risk from a combination of (i) coastal development, (ii) overexploitation and destructive fishing practices, (iii) impact of inland pollution and erosion, and (iv) marine pollution, are the reefs around Aceh and the islands off Sumatra in Indonesia; Malaysia west coast; Myanmar; Sri Lanka and the Gulf of Mannar (Bryant et al., 1998; Reefbase, 2010). In the Gulf of Mannar, Palk Bay and Andaman Islands, it is projected that the coral reefs will become remnant by the year 2060 due to seawater warming (Vivekanandan et al., 2009).

Sewage-borne pathogens and organic load from sewage and other discharges are becoming major issues as a consequence of increasing dwelling units in the coastal areas. Marine litter, including plastic and discarded fishing gear, are other major issues, which are transported long distances in the marine environment.

4. Drivers

The TDA process identified several key drivers which contribute to these issues. These include 1. Socio-economic drivers; 2. Institutional, legal and administrative drivers; and 3. Climate change.

4.1. Socio-economic drivers

Vulnerability assessments made by IOC-UNESCO and UNEP (UNEP 2016) by measuring the environmental risks, dependence on marine ecosystem services, and capacity to respond and adapt to threats of coastal populations bordering several LMEs showed that people in highly populated tropical regions are the most at risk (based on the index). The BOBLME has been identified as having one of the highest

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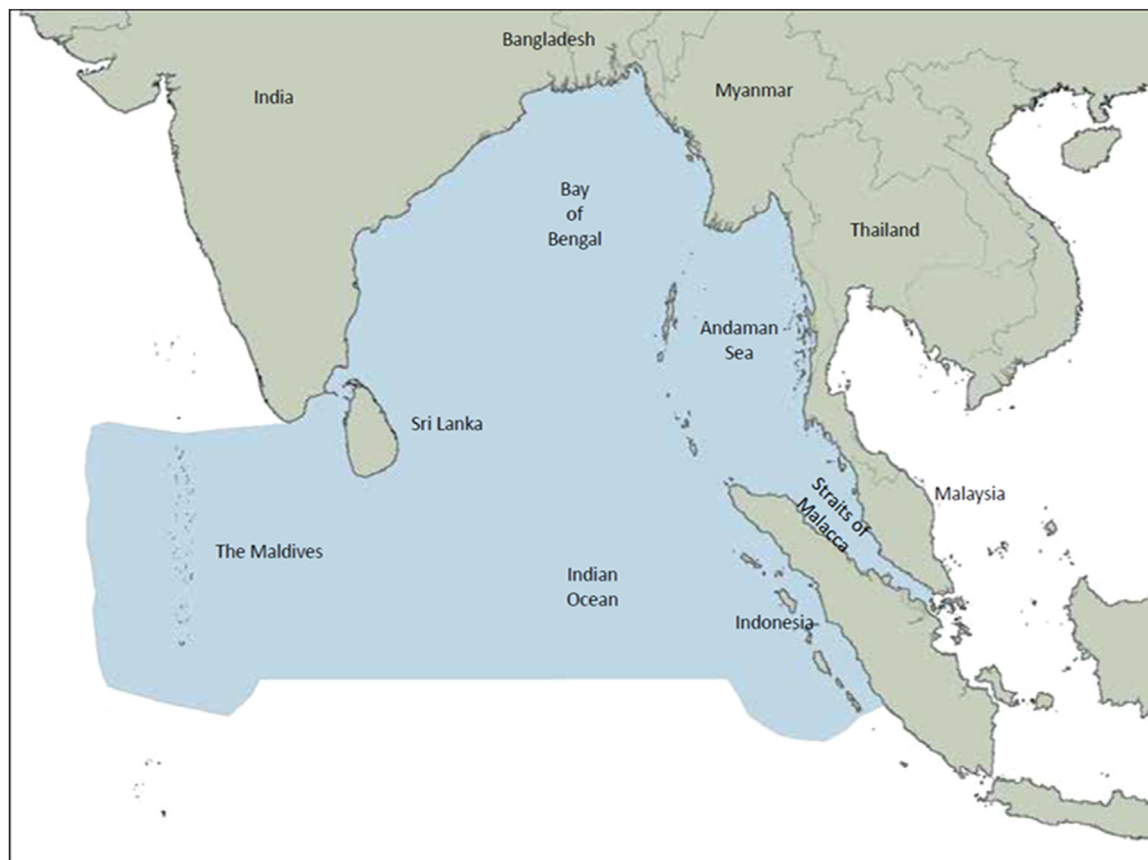[1] For more information see www.boblme.org.

Fig. 1. Bay of Bengal LME and the rim countries.

Table 1
Profile of Bay of Bengal Large Marine Ecosystem.
(Source: * BOBLME, 2015a; ** BOBLME, 2014a)

Features	Facts	Remarks
Total maritime area*	6.2 million km^2	High seas area is 32%
Total area of EEZ*	4.3 million km^2	68% of area is within EEZ of countries
Combined length of coastline*	14,000 km	-
Employment in fisheries*	4.5 million	-
Number of fishers**	3.7 million	-
Number of fishing boats**	294,000	-
Annual fish production**	6.0 million tonnes	> 7% of world's catch
Annual aquaculture production**	1.3 million tonnes	-
Annual value of fisheries production**	USD 32.4 billion	-
Annual value of aquaculture production**	USD 8.5 billion	-
Mangrove area**	15,792 km^2	8% of the world's mangroves
Coral reef area**	8471 km^2	12% of the world's coral reefs
Value of coastal and marine ecosystem services**	USD 72.3 billion	-

risk levels due to very high density of coastal populations.

The principal social factors affecting BOBLME countries are: (i) rapid population growth; (ii) economic growth, e.g. establishment of tourist resorts, ports, airports, roads, harbours in the coastal areas; and (iii) lack of stakeholder awareness of the issues and, in some cases, lack of stressor mitigation commitment.

4.2. Institutional, legal and administrative drivers

At the national level, underpinning these key issues is poor enforcement of laws and regulations, lack of monitoring; lack of co-ordination between different enforcement agencies; poor integrated planning and inadequate communication; inadequate stakeholder engagement in planning, decision-making, implementation and enforcement; inadequate management capacity at all levels for managing a multiple-use, multiple-stakeholder resource; inadequate funding for the implementation and enforcement of legislation.

BOBLME countries recognize that the causes and solutions of priority issues extend beyond one or more national political jurisdiction. There are many benefits to be gained from addressing these issues through coordinated action at the regional level by establishing a supportive institutional and legal framework to facilitate inter-sectoral and transboundary planning and management between the BOBLME member countries.

There are a multitude of agencies and organisations with a partial mandate to coordinate some activities related to fisheries, habitats and pollution in the BOBLME region. The following twelve sub-regional, regional and international institutions and MoUs exist in and around

Table 2
Major and specific issues, and proximate causes in the BOBLME (modified after BOBLME, 2015a).

Major issues	Specific issues	Causes
Over exploitation of marine living resources	1. Decline in fish resources 2. Changes in species composition of species 3. High proportion of juvenile fish in catch	• Excessive fishing effort and overcapacity • Destructive fishing methods • Inappropriate fishing practices • Illegal, unregulated and unreported fishing
Degradation of critical habitats	1. Loss and degradation of mangrove habitats 2. Degradation of coral reefs 3. Loss and damage to seagrasses	• Expanding coastal development • Coastal modification, including coral and sand mining, dredging and reclamation • Lack of clear land tenure • Unsustainable logging of mangroves • Increasing pollution, eutrophication and sedimentation • Destructive fishing practices • Natural causes
Pollution and water quality	1. Sewage-borne pathogens and organic load 2. Solid waste/marine litter 3. Increasing nutrient inputs 4. Oil pollution 5. Persistent organic pollutants (POPs) and persistent toxic substances (PTSs) 6. Sedimentation 7. Heavy metals	• Discharge of untreated/inadequately treated domestic, industrial and agricultural wastewater • Discharge of solid waste into rivers and coastal waters • Increasing emissions of nutrients from fertilizer use in agriculture, atmospheric emissions from industry and fossil fuel burning • Routine operational discharges of oil from shipping and dumping of waste oil by vessels

the BOBLME (BOBLME, 2014b):

Asia-Pacific Fisheries Commission (APFIC)
Association of Southeast Asian Nations (ASEAN)
Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC)
Bay of Bengal Programme – Intergovernmental Organisation (BOBP-IGO)
Coordinating Body for the Seas of East Asia (COBSEA)
Memorandum of Understanding on the Conservation and Management of Dugongs (Dugong MoU)
Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA) Indian Ocean Tuna Commission (IOTC)
Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) South Asian Association for Regional Cooperation (SAARC)
South Asia Co-operative Environment Programme (SACEP)
Southeast Asian Fisheries Development Center (SEAFDEC)

All of these are relevant to the BOBLME Project and its goals and objectives, but their geographical scope is either wider or smaller than the Bay of Bengal, covering either additional, or fewer countries; or their respective mandates are not in line with the Project's key thrusts – not covering both fisheries and environment (including related socio-economic aspects).

4.3. Climate change

The Bay of Bengal is one of the warmest ocean areas in the world and it appears that water temperatures are slowly increasing. Evidence is accumulating showing the long-term changes in seawater temperature, acidity, deoxygenation, cyclones and sea level in the BOBLME (Vivekanandan et al., 2016). These changes have impacts on ocean productivity, habitats and biological processes. Distributional and phenological changes in fish species, and increase in frequency and intensity of coral bleaching are becoming evident. Fisheries, particularly traditional fisheries, will be the most vulnerable to climate change.

5. BOBLME SAP highlights

The Bay of Bengal Large Marine Ecosystem Project agreed to a

Strategic Action Programme (SAP) (BOBLME, 2015b) with four key objectives:

1. Fisheries and other marine living resources are restored and managed sustainably;
2. Degraded, vulnerable and critical marine habitats are restored, conserved and maintained;
3. Coastal and marine pollution and water quality are controlled to meet agreed standards for human and ecosystem health; and
4. Social and economic constraints are addressed, leading to increased resilience and empowerment of coastal people.

The SAP also identified 191 potential actions that could (or should) be undertaken to address the objectives. These are grouped under four broad headings, namely:

1. Institutional arrangements, legal and policy reforms;
2. Management measures;
3. Knowledge strengthening, awareness and communication; and
4. Human capacity development.

These potential actions are expected to bridge the findings of the Project with future strategies to adopt the opportunities.

Analysis of the SAP was used to identify, under each major objective, where these activities were or will be addressed by participating counties. Many of these are already being addressed at different scales whilst others await to be addressed. Analysis of the SAP showed that 70.7% of potential actions are being undertaken to some extent by countries (Table 3). Among the objectives, the lowest score (66.1%) was for addressing the social and economic constraints and among the actions, the lowest score was for knowledge strengthening, awareness and communication (61.9%).

It is important that BOBLME countries recognise that the causes and solutions of priority issues extend beyond one or more national political jurisdictions. In this regard, there are many benefits to be gained from addressing these issues through coordinated action at the regional level. This can be achieved by establishing a supportive institutional and legal framework, which will facilitate inter-sectoral and transboundary planning and management among the BOBLME countries. BOBLME activities and reform agendas need to be assessed against the overall legal, administrative and political context and constraints of the countries in the region individually and collectively. The regional context is particularly important because the BOBLME countries share

Table 3
Summary and ranking of national actions being undertaken by 8 countries in the BOBLME SAP document (the numbers refer to the percentage of actions being undertaken on a regional basis; the number in parenthesis refer to the total number of actions identified under each objective and action).

Objective	Institutional arrangements, legal & policy reforms	Management measures	Knowledge strengthening, awareness, communication	Human capacity development	Total
Fisheries and other living resources are restored & managed sustainably	86.5 (12)	66.3 (23)	63.9 (9)	68.3 (13)	70.6 (57)
Critical habitats are restored & conserved	79.2 (15)	78.1 (16)	63.9 (9)	76.1 (11)	75.5 (51)
Pollution & water quality are controlled	70.0 (15)	72.6 (21)	60.4 (12)	68.8 (4)	68.8 (52)
Social & economic constraints are addressed	83.3 (9)	40.0 (5)	60.0 (10)	71.4 (7)	66.1 (31)
Total	**78.9 (51)**	**69.2 (65)**	**61.9 (40)**	**71.4 (35)**	**70.7 (191)**

the same marine environment, similar issues and national activities have transboundary impacts. However, depending on the relative significance of each of the three issues (and socio-economic considerations) in influencing the ecosystem, policy and organizational prescriptions will be expected to vary between the countries.

Management of the BOBLME can be considerably strengthened by improving the quality of data and information and by assessments at sub-LME scales. Much of the available data are characterized by varying levels of uncertainty as well as by spatial and temporal gaps, which can be addressed in the future through research and monitoring and observing programmes. Assessments are also needed at sub-LME scales, so that actions can be taken to address pressures and impacts at the appropriate scale. This requires the availability of data and information at the appropriate geographic scale.

Support for transboundary planning and management has tended to increase, rather than decline, over time, for example, the implementation of BOBLME project. A comparison of approaches to manage large marine areas made by Bensted-Smith and Kirkman (2010) shows that authorities and stakeholders have growing interest in a holistic approach to conservation and development based on their natural resources, where valuable, multidisciplinary information is available, where there are traditional rights to build on and where the governance hierarchy is relatively simple and free from the complications and slow processes that multi-country LMEs have to deal with.

5.1. The national-regional interface

Good regional ocean governance in the BOBLME will require greater attention to the national level arrangements for engagement with agencies and projects at the regional level. Development and enhancement of national level, multi-stakeholder mechanisms will also provide improved integration at the national level. National-state/provincial relationships, as well as State/provincial-local relationships are also important. If such arrangements are achieved, together, they will comprise a nested governance architecture for the region (BOBLME, 2015c).

5.2. Fisheries ecosystem assessments

As conventional fisheries assessments do not take into account ecological and ecosystem considerations, researchers in the BOBLME region have developed ecosystem models, particularly the Ecopath with Ecosim models in the last 20 years. These models cover a country's coastal area and have been built with a specific goal in mind, for example, to explore the effects of fishing in general, or the effects of one specific fishery, or the role of a group of species. A few such models are listed here: Gulf of Thailand (Christensen, 1998; Vibunpant et al., 2003); Sri Lanka (Haputhantria et al., 2008); Bangladesh (Mustafa, 2003; Rashed-Un-Nabi and Ullah, 2012); West coast of Peninsular Malaysia (Alias, 2003); Southwest coast of India (Vivekanandan et al., 2003); Southeast coast of India (Antony et al., 2010), Karnataka coast in the southeastern Arabian Sea of India (Mohamed et al., 2008), Sabay and Sarawak, Malaysia (Garces et al., 2003) and Tangerang coastal waters, Indonesia (Dewi et al., 2018). While ecosystem modelling is an important tool for evaluating the ecosystem and developing scenarios, there are not many instances, unfortunately, in which models have been incorporated as part of the management process.

5.3. Ecosystem approach to fisheries management (EAFM)

Traditionally, fisheries management has been the sole responsibility of the fisheries ministries. For an ecosystem approach, holistic management involving cross-sectoral collaboration is essential. The ministries responsible for the environment, and other ministries or departments are essential partners for the fisheries ministries in an ecosystem approach to management.

EAFM is a practical way to apply sustainable development principles to the management of fisheries and achieve a balance between ecological and social well-being. It considers the impacts of fishing on other sectors, as well as the impacts of other sectoral activities on the fisheries resources and marine habitats and ecosystem health. The purpose of the EAFM process in the BOBLME is to offer a better and more holistic way to manage complex marine fisheries, and to develop and implement an integrated set of management arrangements so that a fishery may generate more acceptable, sustainable and beneficial community outcomes. Key principles of the EAFM include good governance, appropriate scale, increased participation, multiple objectives, coordination and cooperation, adaptive management and a precautionary approach.

The BOBLME Project had promoted EAFM through a wide range of activities. Recognizing that at the start of the project EAFM was still not well known and that there was widespread uncertainty on how to apply it, the Project supported a consortium of partners in the development of capacity and through newly designed training courses such as the "Essential EAFM" for mid-level managers, complemented by a higher level "EAFM LEAD" for policy and decision makers. This course material was treated as open source, and shared with numerous partners and has been translated to several languages (www.eafmlearn.org).

EAFM was further mainstreamed into the assessment of two important shared and transboundary fish resources (*Hilsa shad Tenualosa ilisha* and *Indian mackerel Rastrelliger kanagurta*), in the development of management advisories as well for the drafting of several National Plans of Action (NPOA) for Sharks. It was also promoted in activities undertaken with key partner institutions Bay of Bengal Programme – Intergovernmental Organisation (BOBP-IGO), Indian Ocean Tuna Commission (IOTC) and Southeast Asian Fisheries Development Center (SEAFDEC), as well as other research and capacity development partners. Important BOBLME Project undertakings such as the region-wide ecosystem characterization and ecosystem services valuation were also guided by applying key EAFM principles and processes. The ecosystem surveys carried out by RV Dr Fridtjof Nansen in Myanmar, in partnership with the EAF Nansen Project (FAO-Norway) also promoted EAF approaches.

To provide basic knowledge on the EAFM process and how this process can assist in decision-making for responsible and sustainable fisheries, the BOBLME project conducted 23 training events and 8 training of trainers (ToT) spanning a two-year period (2013–2015) in the region. A total of 645 researchers and managers were trained in events conducted in Bangladesh, India, Sri Lanka, Indonesia, Malaysia, Thailand and Philippines. The training was designed for personnel, including staff of economic development and planning agencies, who are responsible for administering fisheries and marine environments at the provincial or state and district or local levels. The core aim was for participants to develop professional planning skills for more effective and equitable management of fisheries, responding to the need for regional capacity development that has been identified by representatives of fisheries agencies and institutions within the wider Asia-Pacific region through intergovernmental and regional fisheries processes. The BOBLME project also conducted EAFM LEAD workshop to provide leaders, executives and decision-makers with improved understanding of, and an ability to initiate and support the implementation of an EAFM on different levels of government and across sectors. The LEAD toolkit is designed to assist EAFM champions and facilitators to acquaint leaders with EAFM, encourage leadership engagement in an EAFM and help leaders to empower their people to implement an EAFM. These capacity building programmes are a pragmatic approach to understand how conventional fisheries management can be improved to incorporate ecosystem considerations and more properly deal with the social dimension.

Despite the progress made in promoting application of an ecosystem approach the project identified that implementation of the plans still remains a challenge. The key barriers to implementation of EAFM were found to be manifold and included 1) that the current issues facing fisheries are far more complex than before making the work of fisheries managers more difficult and challenging, 2) where conventional fisheries management is not well-grounded it is difficult to integrate ecosystem aspects of management into fisheries management framework, 3) in some countries where the fisheries authorities also provide welfare to fishers it is difficult for them to change perceptions and move away from traditional roles of beneficiary to partner (in co-management), 4) fisheries management remains bounded by historical jurisdictions rather than ecological ones, and 5) moving from conventional fisheries management to EAFM requires a major policy change and leadership (the interest to effect this change will vary depending on each government's priorities, laws, administration, resources, uses, and socio-economics and other factors). Thus, the lack of good governance arrangements, not only the lack of ecological data, is the impediment in progressing towards implementing EAFM.

Despite these challenges, the BOBLME noted encouraging developments in the region in implementation of EAFM and co-management system that is in the heart of EAFM process. The following three case studies are worth mentioning in this context:

(i) *EAFM planning guideline in Kalpitiya, Sri Lanka*: The applicability and relevance of biological and socioeconomic tools to follow EAFM planning guidelines in a data absent area were explored in Kalpitiya (Mattingley et al., 2016), northwest Sri Lanka, where there is a population of spinner dolphin that the local community is dependent on through tuna-dolphin association fishing and dolphin-watching tourism. It was concluded that willingness of higher level stakeholders responsible for implementing regulations and working with grass-root level stakeholders are critical in developing a realistic and implementable EAFM plan. This work also highlights how data absence should not remain the bottleneck that hinders moving forward with EAFM approaches.

(ii) *Eco-labelling clam fisheries of Ashtamudi, Kerala, India:* Short-necked clams form an important constituent of fisheries in Ashtamudi, a palm-shaped estuary in Kerala, southwest coast of India. The clams are harvested by diving and handpicking and hand-dredging. Over half of the fisheries economy of Ashtamudi is attributed to clams alone. Besides contributing significantly to the livelihoods of over 3000 clam fishers, clams also constitute an important component of lake ecology, acting as effective biofilters and increasing nutrient supply in the aquatic environment. Ashtamudi clam harvest underwent a decline in the 1990s mainly due to use of indiscriminate fishing practices. The Ashtamudi Clam Governing Council was constituted with co-management and ecosystem approach as the main focus with the District Collector as Chairman, the Deputy Director of Fisheries as Convenor, and 10 clam fishers and 10 other stakeholders as members. The Council periodically meets and addresses issues and takes decisions including those related to implementation of mesh-size regulation and minimum size of clams that can be harvested. The council is responsible for fixing a minimum price for the meat of the clams. It also issues identity cards for fishers, and restricts new entrants into the fishery. These measures helped revive the resource considerably, yet economic value realization to fishers remained low. To assist communities in realizing higher value from a sustainably managed resource, certification for the fishery was sought from the Marine Stewardship Council (MSC), and the Ashtamudi shortnecked clam fishery became the first certified fishery in India. Economic assessments indicated that the benefit from certification was at least 1.8 times higher than the cost (Mohamed et al., 2013).

(iii) *Co-management in southeast coast of India*: Fisheries Management for Sustainable Livelihoods (FIMSUL), is a project under the World Bank Trust Fund and implemented by the Food and Agriculture Organisation of the United Nations (FAO) with the Governments of Tamil Nadu and Puducherry in southeast coast of India. Phase 1 of

the project aimed at establishing frameworks, processes and building capacities of various stakeholders especially the government, to facilitate the planning, design and implementation of appropriate fisheries development and management policies. One of the conclusions of Phase 1 of the Project was that the government and fishing communities need to work together and fisheries management in the two States can succeed only in the form of co-management (FIMSUL, 2011). A multi-tiered geographical area-based structure was recommended at the coastal Village, District and State levels. In Phase 2 of the Project, the two States have initiated implementation of the recommendation on marine fisheries co-management involving multiple stakeholders with the support of Bay of Bengal Programme – Intergovernmental Organisation (BOBP-IGO). At the time of writing this Chapter, capacity development programmes for government officials, fishermen and various stakeholders are in progress on the co-management framework and its implementation.

It should be noted that EAFM is highly compatible with the LME approach, and synonymous with Ecosystem-based Management of Fisheries (EBMF) and complementary with Integrated Coastal Management (ICM). ICM as an integrated approach to the management of coastal areas takes into account the requirements of all stakeholders in the coastal zone to achieve sustainable development. There is a strong need for qualified coastal managers and policy makers with the knowledge, tools and skills to design and implement sustainable ICM programmes for countries in the BOBLME region, and the BOBLME Project cooperated with the Partnership for Environmental Management for the Seas of East Asia (PEMSEA) to address these capacity development needs.

5.4. Application of the small-scale fishery guidelines

The Voluntary Guidelines for Securing Sustainable Small-scale Fisheries (SSF Guidelines) were created as a result of a very long history of the struggles of small-scale fishworkers around the world appealing for greater recognition of their status and their role in the fisheries sector of their countries. These guidelines address small-scale fisheries and encompass all the activities along the whole value chain undertaken by both men and women and serve to enhance global food security; promote its contribution to the economic and social future of the planet; contribute to improve the socioeconomic situation of fishworkers and achieve sustainable use of fishery resources (FAO, 2015).

In line with the EAFM principles, particularly those of increased participation and good governance, the BOBLME Project had also supported the drafting of these guidelines through co-hosting of several

workshops, and promoted the awareness raising and dissemination in its member countries in partnership with several NGOs. It also supported the sub-regional action planning on implementation of guidelines in South and Southeast Asia.

6. Governance

The eight countries bordering the Bay of Bengal have differences in governmental organisation, processes and priorities, levels of economic development, degrees of scientific capability (and the ability to incorporate science into the policy process), patterns of social organisation, culture, and values and political relations with neighbouring states. However, despite these variations, administrative structures and national marine conservation and utilisation legislation share similar characteristics and constraints. The formal policies to form strategies and implementation action plans for fisheries and marine environmental management have been reasonably successful in the countries around the Bay of Bengal. There is a surprising degree of similarity between the main policy trends, the issues included in policy and the strategies being used to manage the fisheries sector. Although policy content could be improved, greater challenges lie in implementing policy and in improving policy processes. It is important to note that EAFM and its principles have been incorporated in several national (master) plans, polices, and laws relating to marine fisheries, or adopted as guiding principles or key inputs to improve management of marine fisheries. These countries include at the time of writing India, Indonesia, Malaysia and Myanmar and Maldives.

7. Outlook – towards SAP implementation

To identify the improvements that are required for achieving success in meeting the objectives of the SAP, a Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis was carried out by analysing the publications of BOBLME Project on Transboundary Diagnostic Analysis (TDA) (BOBLME, 2012a, 2012b) and Strategic Action Programme (BOBLME, 2015b). Volume 1 of TDA (2012a) focuses on transboundary issues and presents a causal chain analysis that identifies the proximate and root causes of the issues. Volume 2 (BOBLME, 2012b) describes the scope and characteristics of the BOBLME; the legal, administrative and political context and constraints; assessment of marine living resources and the environment (including critical habitats and pollution); and the background to the BOBLME transboundary issues. SWOT analysis (Table 4) from these sets of documents suggests that achievement of objectives of the BOBLME SAP will require improvements in the following areas of governance:

Table 4
SWOT analysis of the BOBLME SAP.
(Source: BOBLME, 2012a, 2012b; BOBLME, 2015b).

Strengths	Weaknesses
✓ Large ecologically productivity areas; ✓ Rich biodiversity; ✓ Abundant fish resources; ✓ Operation of specific regional projects/ organisation like BOBLME, BOBP-IGO provides a mechanism for regional cooperation, coordination and collaborative actions; ✓ Availability of Transboundary Diagnostic Analysis and Strategic Action Plan for the LME prepared by the BOBLME; ✓ Existence of management regime in each country.	✓ Lack of clear policy and coordinated approach within and between countries; ✓ Weak regional cooperation; ✓ Weak implementation of management measures; ✓ Non-availability of high quality multidisciplinary data; ✓ Erosion of ecosystem service values.
Opportunities	**Threats**
✓ Agreement to several regional and international treaties; ✓ Learning from international best practices; ✓ Increased participation of communities in ecosystem management; ✓ Building institutional capacity to work at multiple levels; ✓ Institutionalising transboundary cooperation.	✓ Dense human population; ✓ Large dependent population on coastal resources; ✓ Challenge of governance across sectors and at all levels, from local to regional, among the 8 countries; ✓ Importance given by all countries in the region for economic development of coastal areas; ✓ Lack of political commitment for regional action plan.

- Increased political priority given to the management of marine living resources, critical habitats, pollution, water quality and social and economic factors;
- More effective enforcement of laws and regulations;
- Stronger coordination between fisheries and environment agencies, including research organisations;
- Stronger coordination between enforcement agencies;
- Integrated planning across different levels of governance — central, state (provincial) and local government;
- Improved local stakeholder participation in planning, decision-making, implementation and monitoring;
- Increased budgetary commitments for implementation and enforcement of legislation; and
- Increased compliance with rules and regulations.

For the BOBLME, the starting point is the establishment of a governance structure at the regional level, in most cases linked to a regional convention. The inter-governmental body must be linked to national governments, usually through a designated focal point. For effective governance, the focal point must be linked adequately to other sectors of national governments, to lower levels of government and to civil society organisations and stakeholders, and each player in this system should have the capacity to fulfil its role in governance. The effectiveness of the LME in achieving their ecosystem productivity and sustainability objectives will depend on the extent to which the transboundary and national levels of governance are connected to sub-national and local levels in governance systems that function effectively as a whole.

Implementation of ecosystem management at the regional level in the BOBLME will need the capacity to undertake monitoring of the whole ecosystem and to plan and coordinate management activities at regional level. The BOBLME participating counties have agreed tentatively on an arrangement in the form of a consortium. The consortium would include countries and major partners and donors working in the areas of fisheries, environment, water quality and their social and economic dimensions. The "Consortium for the Conservation and Restoration of the BOBLME" (CCR-BOBLME) would meet regularly to promote information exchange and capacity development, monitor BOBLME health and status and to monitor progress of the SAP implementation activities and project. The establishment of the CCR-BOBLME will involve the development of a cooperative agreement between many partners and countries.

With a decision by the GEF to provide funding support for the SAP Implementation Phase and to contribute a Project Preparation Grant, a series of intensive consultations with country and partner agencies will resume in 2019, with the aim to develop a Project Document, which will detail the commitment of all to continue the collaboration in the BOBLME to better the lives of their coastal populations by improving regional management of the Bay of Bengal environment and its fisheries.

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